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ADC1112D125

Dual 11-bit ADC; CMOS or LVDS DDR digital outputs

Rev. 03 — 2 July 2012

Product data sheet

1. General description

The ADC1112D125 is a dual channel 11-bit Analog-to-Digital Converter (ADC) optimized for high dynamic performance and low power consumption. Pipelined architecture and output error correction ensure the ADC1112D125 is accurate enough to guarantee zero missing codes over the entire operating range. Supplied from a single 3 V source, it can handle output logic levels from 1.8 V to 3.3 V in Complementary Metal Oxide Semiconductor (CMOS) mode, because of a separate digital output supply. It supports the Low Voltage Differential Signalling (LVDS) Double Data Rate (DDR) output standard. An integrated Serial Peripheral Interface (SPI) allows the user to easily configure the ADC. The device also includes a programmable full-scale SPI to allow a flexible input voltage range of 1 V (p-p) to 2 V (p-p). With excellent dynamic performance from the baseband to input frequencies of 170 MHz or more, the ADC1112D125 is ideal for use in communications, imaging and medical applications.

2. Features and benefits

- SNR, 66.2 dBFS
- SFDR, 87 dBc
- Sample rate up to 125 Msps
- Clock input divided by 2 to reduce jitter contribution
- Single 3 V supply
- Flexible input voltage range: 1 V (p-p) to 2 V (p-p)
- CMOS or LVDS DDR digital outputs
- Power-down and Sleep modes
- Input bandwidth, 600 MHz
- Power dissipation, 1230 mW
- Serial Peripheral Interface (SPI)
- Duty cycle stabilizer
- Fast Out-of-Range (OTR) detection
- Pin and software compatible with ADC1412D series and ADC1212D series.
- Offset binary, two's complement, gray code
- HVQFN64 package

3. Applications

- Wireless and wired broadband communications
- Spectral analysis
- Ultrasound equipment
- Portable instrumentation
- Imaging systems
- Software defined radio



4. Ordering information

Table 1. Ordering information

Type number	f _s (Msps)	Package		Version
		Name	Description	
ADC1112D125HN-C1	125	HVQFN64	plastic thermal enhanced very thin quad flat package; no leads; 64 terminals; body 9 × 9 × 0.85 mm	SOT804-3

5. Block diagram

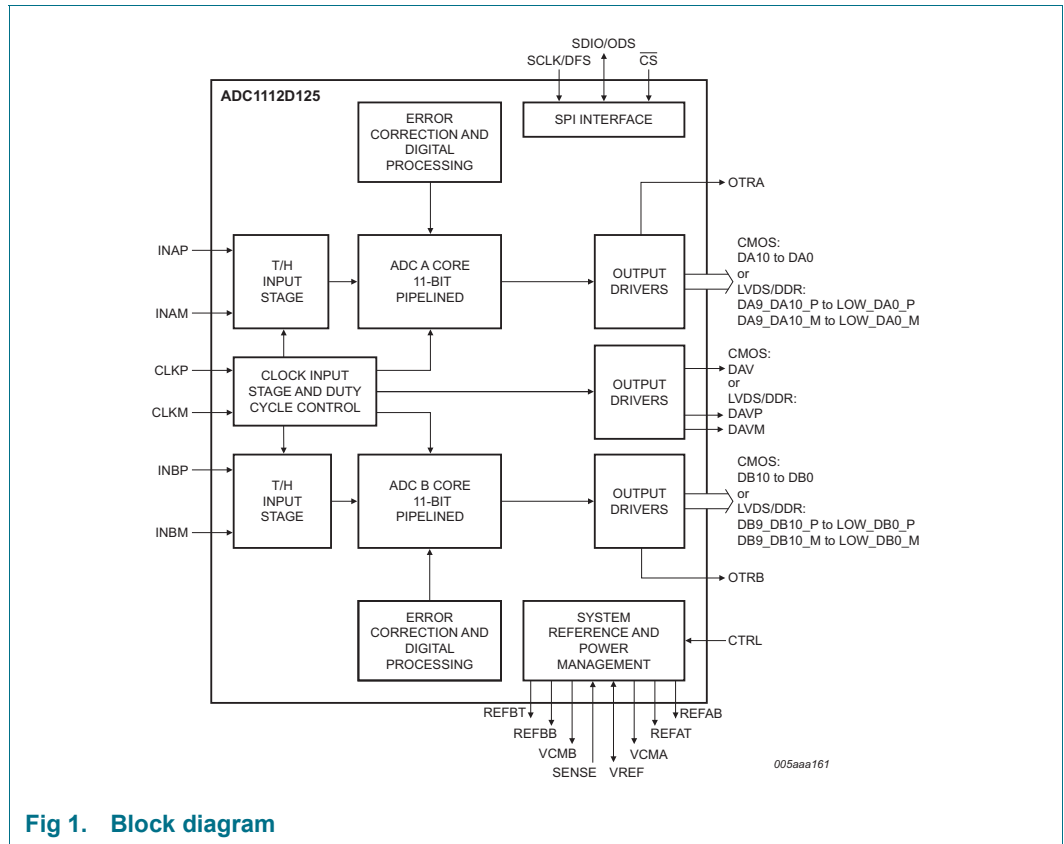


Fig 1. Block diagram

6. Pinning information

6.1 CMOS outputs selected

6.1.1 Pinning

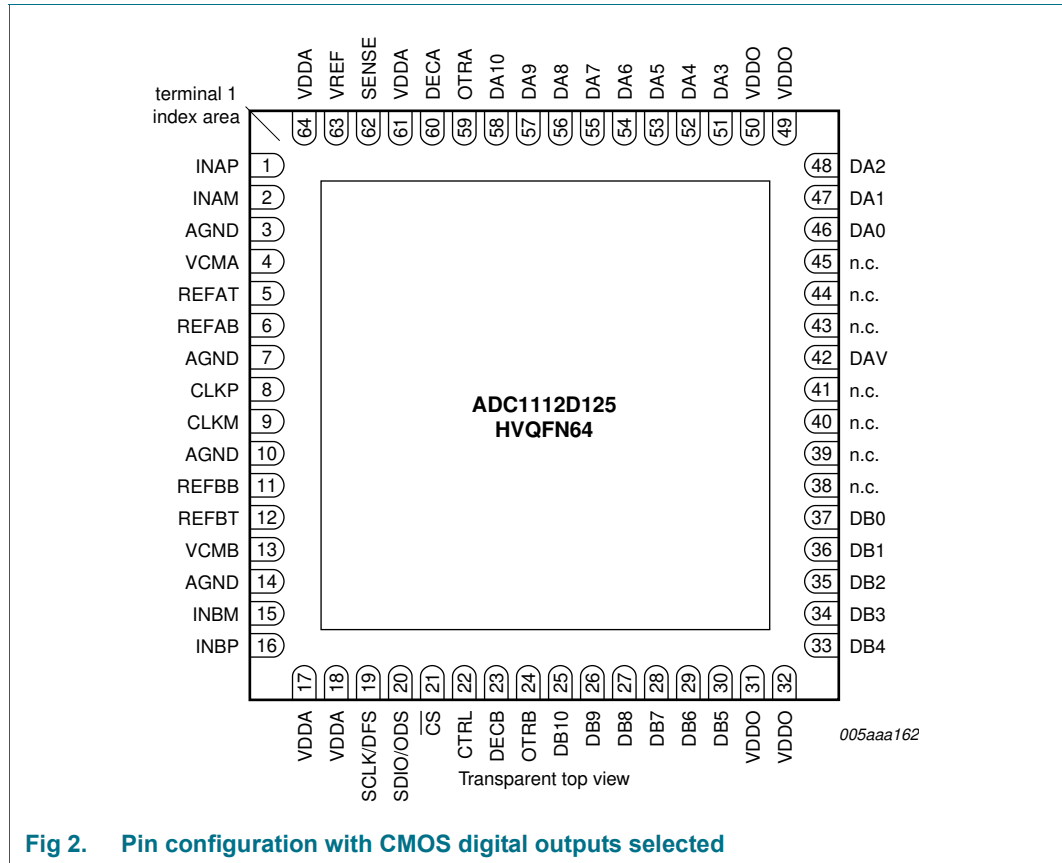


Fig 2. Pin configuration with CMOS digital outputs selected

6.1.2 Pin description

Table 2. Pin description (CMOS digital outputs)

Symbol	Pin	Type ^[1]	Description
INAP	1	I	analog input; channel A
INAM	2	I	complementary analog input; channel A
AGND	3	G	analog ground
VCMA	4	O	common-mode output voltage; channel A
REFAT	5	O	top reference; channel A
REFAB	6	O	bottom reference; channel A
AGND	7	G	analog ground
CLKP	8	I	clock input
CLKM	9	I	complementary clock input
AGND	10	G	analog ground
REFBB	11	O	bottom reference; channel B
REFBT	12	O	top reference; channel B

Table 2. Pin description (CMOS digital outputs) ...continued

Symbol	Pin	Type ^[1]	Description
VCMB	13	O	common-mode output voltage; channel B
AGND	14	G	analog ground
INBM	15	I	complementary analog input; channel B
INBP	16	I	analog input; channel B
VDDA	17	P	analog power supply
VDDA	18	P	analog power supply
SCLK/DFS	19	I	SPI clock/data format select
SDIO/ODS	20	I/O	SPI data input/output/output data standard
$\overline{\text{CS}}$	21	I	SPI chip select, active LOW
CTRL	22	I	control mode select
DECB	23	O	regulator decoupling node; channel B
OTRB	24	O	out-of-range; channel B
DB10	25	O	data output bit 10 (Most Significant Bit (MSB)); channel B
DB9	26	O	data output bit 9; channel B
DB8	27	O	data output bit 8; channel B
DB7	28	O	data output bit 7; channel B
DB6	29	O	data output bit 6; channel B
DB5	30	O	data output bit 5; channel B
VDDO	31	P	output power supply
VDDO	32	P	output power supply
DB4	33	O	data output bit 4; channel B
DB3	34	O	data output bit 3; channel B
DB2	35	O	data output bit 2; channel B
DB1	36	O	data output bit 1; channel B
DB0	37	O	data output bit 0 (Least Significant Bit (LSB)); channel B
n.c.	38	O	not connected
n.c.	39	O	not connected
n.c.	40	O	not connected
n.c.	41	-	not connected
DAV	42	O	data valid output clock
n.c.	43	O	not connected
n.c.	44	O	not connected
n.c.	45	O	not connected
DA0	46	O	data output bit 0 (LSB); channel A
DA1	47	O	data output bit 1; channel A
DA2	48	O	data output bit 2; channel A
VDDO	49	P	output power supply
VDDO	50	P	output power supply
DA3	51	O	data output bit 3; channel A
DA4	52	O	data output bit 4; channel A
DA5	53	O	data output bit 5; channel A
DA6	54	O	data output bit 6; channel A
DA7	55	O	data output bit 7; channel A
DA8	56	O	data output bit 8; channel A

Table 2. Pin description (CMOS digital outputs) ...continued

Symbol	Pin	Type ^[1]	Description
DA9	57	O	data output bit 9; channel A
DA10	58	O	data output bit 10 (MSB); channel A
OTRA	59	O	out-of-range; channel A
DECA	60	O	regulator decoupling node; channel A
VDDA	61	P	analog power supply
SENSE	62	I	reference programming pin
VREF	63	I/O	voltage reference input/output
VDDA	64	P	analog power supply

[1] P: power supply; G: ground; I: input; O: output; I/O: input/output.

6.2 LVDS DDR outputs selected

6.2.1 Pinning

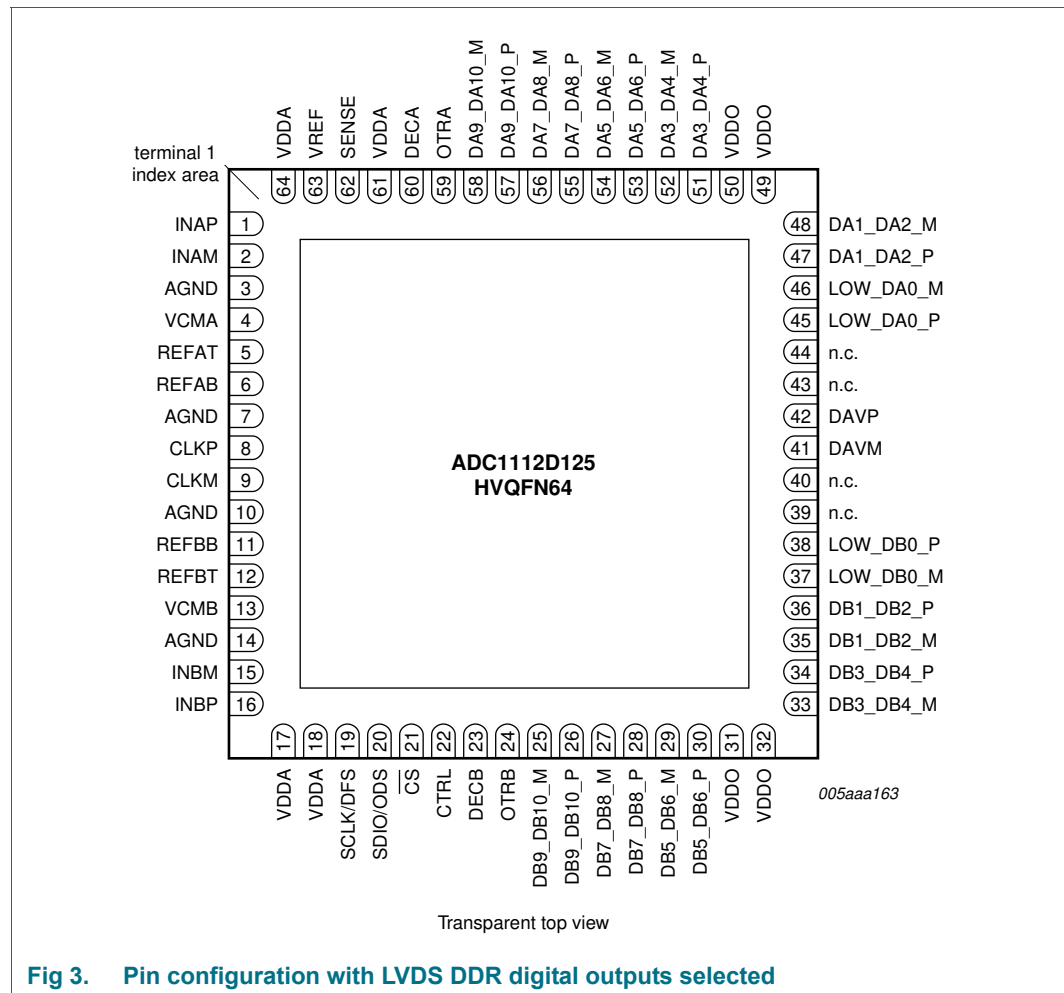


Fig 3. Pin configuration with LVDS DDR digital outputs selected

6.2.2 Pin description

Table 3. Pin description (LVDS DDR) digital outputs)^[1]

Symbol	Pin	Type ^[2]	Description
DB9_DB10_M	25	O	differential output data DB9 and DB10 multiplexed, complement
DB9_DB10_P	26	O	differential output data DB9 and DB10 multiplexed, true
DB7_DB8_M	27	O	differential output data DB7 and DB8 multiplexed, complement
DB7_DB8_P	28	O	differential output data DB7 and DB8 multiplexed, true
DB5_DB6_M	29	O	differential output data DB5 and DB6 multiplexed, complement
DB5_DB6_P	30	O	differential output data DB5 and DB6 multiplexed, true
DB3_DB4_M	33	O	differential output data DB3 and DB4 multiplexed, complement
DB3_DB4_P	34	O	differential output data DB3 and DB4 multiplexed, true
DB1_DB2_M	35	O	differential output data DB1 and DB2 multiplexed, complement
DB1_DB2_P	36	O	differential output data DB1 and DB2 multiplexed, true
LOW_DB0_M	37	O	differential output data DB0 multiplexed, complement
LOW_DB0_P	38	O	differential output data DB0 multiplexed, true
n.c.	39	O	not connected
n.c.	40	O	not connected
DAVM	41	O	data valid output clock, complement
DAVP	42	O	data valid output clock, true
n.c.	43	O	not connected
n.c.	44	O	not connected
LOW_DA0_P	45	O	differential output data DA0 multiplexed, true
LOW_DA0_M	46	O	differential output data DA0 multiplexed, complement
DA1_DA2_P	47	O	differential output data DA1 and DA2 multiplexed, true
DA1_DA2_M	48	O	differential output data DA1 and DA2 multiplexed, complement
DA3_DA4_P	51	O	differential output data DA3 and DA4 multiplexed, true
DA3_DA4_M	52	O	differential output data DA3 and DA4 multiplexed, complement
DA5_DA6_P	53	O	differential output data DA5 and DA6 multiplexed, true
DA5_DA6_M	54	O	differential output data DA5 and DA6 multiplexed, complement
DA7_DA8_P	55	O	differential output data DA7 and DA8 multiplexed, true
DA7_DA8_M	56	O	differential output data DA7 and DA8 multiplexed, complement
DA9_DA10_P	57	O	differential output data DA9 and DA10 multiplexed, true
DA9_DA10_M	58	O	differential output data DA9 and DA10 multiplexed, complement

[1] Pins 1 to 24, pin 59 to 64 and pins 31, 32, 49 and 50 are the same for both CMOS and LVDS DDR outputs (see Table 2).

[2] P: power supply; G: ground; I: input; O: output; I/O: input/output.

7. Limiting values

Table 4. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
V_O	output voltage	pins DA10 to DA0 and DB10 to DB0 or pins DA9_DA10_P to LOW_DA0_P, DA9_DA10_M to LOW_DA0_M, DB9_DB10_P to LOW_DB0_P and DB9_DB10_M to LOW_DB0_M	-0.4	+3.9	V
V_{DDA}	analog supply voltage		-0.4	+3.9	V
V_{DDO}	output supply voltage		-0.4	+3.9	V
T_{stg}	storage temperature		-55	+125	°C
T_{amb}	ambient temperature		-40	+85	°C
T_j	junction temperature		-	125	°C

8. Thermal characteristics

Table 5. Thermal characteristics

Symbol	Parameter	Conditions	Typ	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient		[1] 15.6	K/W
$R_{th(j-c)}$	thermal resistance from junction to case		[1] 6.3	K/W

[1] Value for six layers board in still air with a minimum of 64 thermal vias.

9. Static characteristics

Table 6. Static characteristics^[1]

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Supplies						
V_{DDA}	analog supply voltage		2.85	3.0	3.4	V
V_{DDO}	output supply voltage	CMOS mode	1.65	1.8	3.6	V
		LVDS DDR mode	2.85	3.0	3.6	V
I_{DDA}	analog supply current	$f_{clk} = 125$ Msps; $f_i = 70$ MHz	-	400	-	mA
I_{DDO}	output supply current	CMOS mode; $f_{clk} = 125$ Msps; $f_i = 70$ MHz	-	16	-	mA
		LVDS DDR mode: $f_{clk} = 125$ Msps; $f_i = 70$ MHz	-	82	-	mA
P	power dissipation	ADC1112D125; analog supply only	-	1230	-	mW
		Power-down mode	-	24	-	mW
		Sleep mode	-	80	-	mW

Table 6. Static characteristics^[1] ...continued

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Clock inputs: pins CLKP and CLKM						
Low-Voltage Positive Emitter-Coupled Logic (LVPECL)						
$V_{i(\text{clk})\text{dif}}$	differential clock input voltage	peak-to-peak	-	± 1.6	-	V
Sine						
$V_{i(\text{clk})\text{dif}}$	differential clock input voltage	peak-to-peak	± 0.8	± 3.0	-	V
Low Voltage Complementary Metal Oxide Semiconductor (LVCMOS)						
V_{IL}	LOW-level input voltage		-	-	$0.3V_{\text{DDA}}$	V
V_{IH}	HIGH-level input voltage		$0.7V_{\text{DDA}}$	-	-	V
Logic input: pin CTRL						
V_{IL}	LOW-level input voltage		-	0	-	V
		LOW-medium level	-	$0.3V_{\text{DDA}}$	-	V
		medium-HIGH level	-	$0.6V_{\text{DDA}}$	-	V
V_{IH}	HIGH-level input voltage		-	V_{DDA}	-	V
I_{IL}	LOW-level input current		-10	-	+10	μA
I_{IH}	HIGH-level input current		-10	-	+10	μA
Serial peripheral interface: pins CS, SDIO/ODS, SCLK/DFS						
V_{IL}	LOW-level input voltage		0	-	$0.3V_{\text{DDA}}$	V
V_{IH}	HIGH-level input voltage		$0.7V_{\text{DDA}}$	-	V_{DDA}	V
I_{IL}	LOW-level input current		-10	-	+10	μA
I_{IH}	HIGH-level input current		-50	-	+50	μA
C_{I}	input capacitance		-	4	-	pF
Digital outputs, CMOS mode: pins DA10 to DA0, DB10 to DB0, OTRA, OTRB and DAV						
Output levels, $V_{\text{DDO}} = 3\text{ V}$						
V_{OL}	LOW-level output voltage		AGND	-	$0.2V_{\text{DDO}}$	V
V_{OH}	HIGH-level output voltage		$0.8V_{\text{DDO}}$	-	V_{DDO}	V
C_{O}	output capacitance	high impedance; see Table 10	-	3	-	pF
Output levels, $V_{\text{DDO}} = 1.8\text{ V}$						
V_{OL}	LOW-level output voltage		AGND	-	$0.2V_{\text{DDO}}$	V
V_{OH}	HIGH-level output voltage		$0.8V_{\text{DDO}}$	-	V_{DDO}	V
Digital outputs, LVDS DDR mode: pins DA9_DA10_P to LOW_DA0_P, DA9_DA10_M to LOW_DA0_M, DB9_DB10_P to LOW_DB0_P, DB9_DB10_M to LOW_DB0_M, DAVP and DAVM						
Output levels, $V_{\text{DDO}} = 3\text{ V}$ only, $R_{\text{L}} = 100\ \Omega$						
$V_{\text{O}(\text{offset})}$	output offset voltage	output buffer current set to 3.5 mA	-	1.2	-	V
$V_{\text{O}(\text{dif})}$	differential output voltage	output buffer current set to 3.5 mA	-	350	-	mV
C_{O}	output capacitance		-	3	-	pF
Analog inputs: pins INAP, INAM, INBP and INBM						
I_{I}	input current		-5	-	+5	μA
R_{I}	input resistance		-	19.8	-	k Ω
C_{I}	input capacitance		-	2.8	-	pF
$V_{\text{I}(\text{cm})}$	common-mode input voltage	$V_{\text{INAP}} = V_{\text{INAM}}$; $V_{\text{INBP}} = V_{\text{INBM}}$	0.9	1.5	2	V

Table 6. Static characteristics^[1] ...continued

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
B_i	input bandwidth		-	600	-	MHz
$V_{I(dif)}$	differential input voltage	peak-to-peak	1	-	2	V
Common-mode output voltage: pins VCMA and VCMB						
$V_{O(cm)}$	common-mode output voltage		-	$0.5V_{DDA}$	-	V
$I_{O(cm)}$	common-mode output current		-	4	-	mA
I/O reference voltage: pin VREF						
V_{VREF}	voltage on pin VREF	output	-	0.5 to 1	-	V
		input	0.5	-	1	V
Accuracy						
INL	integral non-linearity		-0.6	± 0.12	+0.6	LSB
DNL	differential non-linearity	guaranteed no missing codes	-0.2	± 0.06	+0.2	LSB
E_{offset}	offset error		-	± 2	-	mV
E_G	gain error	full-scale	-	± 0.5	-	%
$M_{G(CTC)}$	channel-to-channel gain matching		-	1.1	-	%
Supply						
PSRR	power supply rejection ratio	200 mV (p-p) on V_{DDA} ; $f_i = DC$	-	-37	-	dB

[1] Typical values measured at $V_{DDA} = 3\text{ V}$, $V_{DDO} = 1.8\text{ V}$, $T_{amb} = 25\text{ }^\circ\text{C}$; minimum and maximum values are across the full temperature range $T_{amb} = -40\text{ }^\circ\text{C}$ to $+85\text{ }^\circ\text{C}$ at $V_{DDA} = 3\text{ V}$, $V_{DDO} = 1.8\text{ V}$; $V_{INAP} - V_{INAM} = -1\text{ dBFS}$; $V_{INBP} - V_{INBM} = -1\text{ dBFS}$; internal reference mode; applied to CMOS and LVDS interface; unless otherwise specified.

10. Dynamic characteristics

10.1 Dynamic characteristics

Table 7. Dynamic characteristics^[1]

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Analog signal processing						
α_{2H}	second harmonic level	$f_i = 3$ MHz	-	88	-	dBc
		$f_i = 30$ MHz	-	87	-	dBc
		$f_i = 70$ MHz	-	85	-	dBc
		$f_i = 170$ MHz	-	83	-	dBc
α_{3H}	third harmonic level	$f_i = 3$ MHz	-	87	-	dBc
		$f_i = 30$ MHz	-	86	-	dBc
		$f_i = 70$ MHz	-	84	-	dBc
		$f_i = 170$ MHz	-	82	-	dBc
THD	total harmonic distortion	$f_i = 3$ MHz	-	84	-	dBc
		$f_i = 30$ MHz	-	83	-	dBc
		$f_i = 70$ MHz	-	81	-	dBc
		$f_i = 170$ MHz	-	79	-	dBc
ENOB	effective number of bits	$f_i = 3$ MHz	-	10.7	-	bits
		$f_i = 30$ MHz	-	10.7	-	bits
		$f_i = 70$ MHz	-	10.7	-	bits
		$f_i = 170$ MHz	-	10.6	-	bits
SNR	signal-to-noise ratio	$f_i = 3$ MHz	-	66.2	-	dBFS
		$f_i = 30$ MHz	-	66.2	-	dBFS
		$f_i = 70$ MHz	-	66.0	-	dBFS
		$f_i = 170$ MHz	-	65.8	-	dBFS
SFDR	spurious-free dynamic range	$f_i = 3$ MHz	-	87	-	dBc
		$f_i = 30$ MHz	-	86	-	dBc
		$f_i = 70$ MHz	-	84	-	dBc
		$f_i = 170$ MHz	-	82	-	dBc
IMD	Intermodulation distortion	$f_i = 3$ MHz	-	89	-	dBc
		$f_i = 30$ MHz	-	88	-	dBc
		$f_i = 70$ MHz	-	86	-	dBc
		$f_i = 170$ MHz	-	84	-	dBc
$\alpha_{ct(ch)}$	channel crosstalk	$f_i = 70$ MHz	-	100	-	dBc

[1] Typical values measured at $V_{DDA} = 3$ V, $V_{DDO} = 1.8$ V, $T_{amb} = 25$ °C; minimum and maximum values are across the full temperature range $T_{amb} = -40$ °C to $+85$ °C at $V_{DDA} = 3$ V, $V_{DDO} = 1.8$ V; $V_{INAP} - V_{INAM} = -1$ dBFS; $V_{INBP} - V_{INBM} = -1$ dBFS; internal reference mode; applied to CMOS and LVDS interface; unless otherwise specified.

10.2 Clock and digital output timing

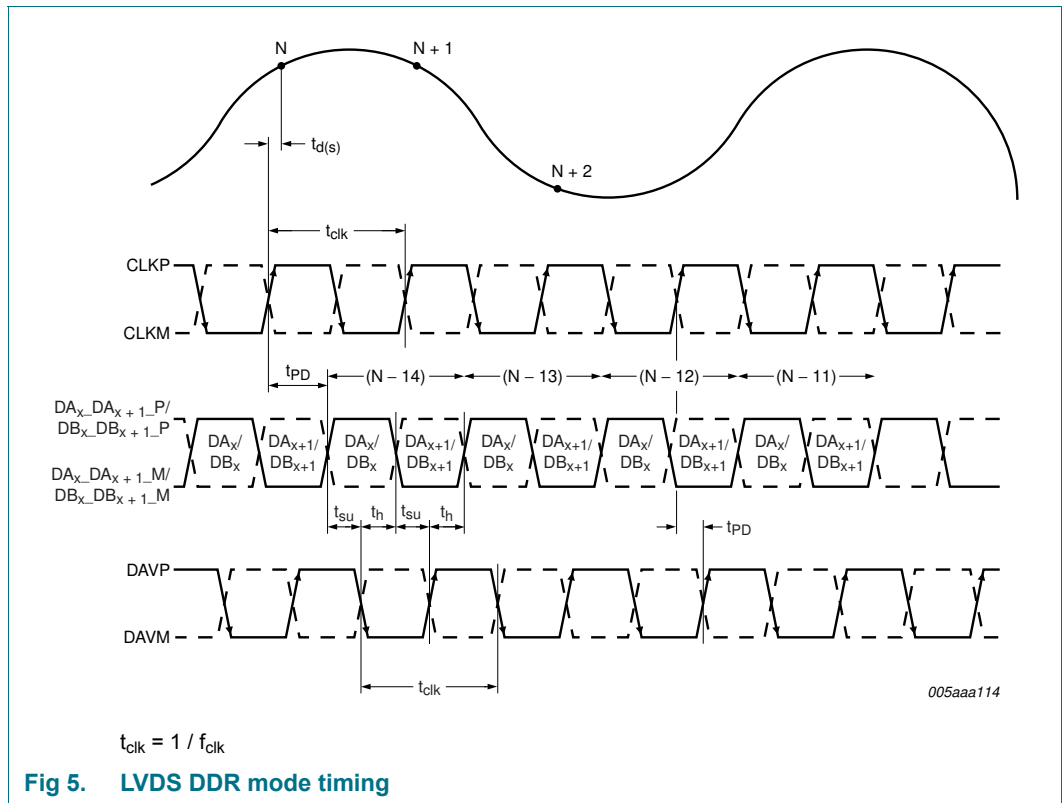
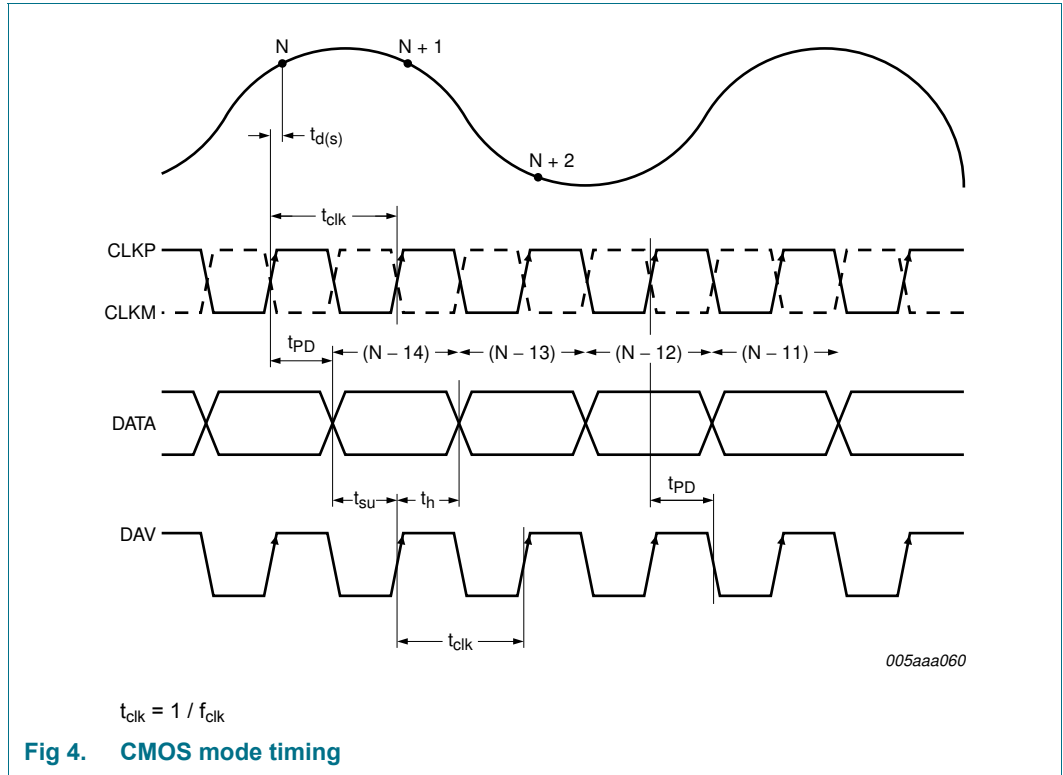
Table 8. Clock and digital output timing characteristics^[1]

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Clock timing input: pins CLKP and CLKM						
f_{clk}	clock frequency		100	-	125	MHz
$t_{\text{lat}}(\text{data})$	data latency time		-	14	-	clock cycles
δ_{clk}	clock duty cycle	DCS_EN = 1	30	50	70	%
		DCS_EN = 0	45	50	55	%
$t_{\text{d}}(\text{s})$	sampling delay time		-	0.8	-	ns
t_{wake}	wake-up time		-	76	-	μs
CMOS mode timing: pins DA10 to DA0, DB10 to DB0 and DAV						
t_{PD}	propagation delay	DATA	-	3.9	-	ns
		DAV	-	4.2	-	ns
t_{su}	set-up time		-	5.7	-	ns
t_{h}	hold time		-	1.4	-	ns
t_{r}	rise time	DATA	^[2] 0.5	-	2.4	ns
		DAV	0.5	-	2.4	ns
t_{f}	fall time	DATA	^[2] 0.5	-	2.4	ns
		DAV				
LVDS DDR mode timing: pins DA9_DA10_P to LOW_DA0_P, DA9_DA10_M to LOW_DA0_M, DB9_DB10_P to LOW_DB0_P, DB9_DB10_M to LOW_DB0_M, DAVP and DAVM						
t_{PD}	propagation delay	DATA	-	3.9	-	ns
		DAV	-	4.2	-	ns
t_{su}	set-up time		-	1.4	-	ns
t_{h}	hold time		-	2.0	-	ns
t_{r}	rise time	DATA	^[3] 50	100	200	ps
		DAV	50	100	200	ps
t_{f}	fall time	DATA	^[3] 50	100	200	ps
		DAV	50	100	200	ps

[1] Typical values measured at $V_{\text{DDA}} = 3\text{ V}$, $V_{\text{DDO}} = 1.8\text{ V}$, $T_{\text{amb}} = 25\text{ }^\circ\text{C}$; minimum and maximum values are across the full temperature range $T_{\text{amb}} = -40\text{ }^\circ\text{C}$ to $+85\text{ }^\circ\text{C}$ at $V_{\text{DDA}} = 3\text{ V}$, $V_{\text{DDO}} = 1.8\text{ V}$; $V_{\text{INAP}} - V_{\text{INAM}} = -1\text{ dBFS}$; $V_{\text{INBP}} - V_{\text{INBM}} = -1\text{ dBFS}$; unless otherwise specified.

[2] Measured between 20 % to 80 % of V_{DDO} .

[3] Rise time measured from -50 mV to $+50\text{ mV}$; fall time measured from $+50\text{ mV}$ to -50 mV .



10.3 SPI timings

Table 9. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
SPI timings						
$t_{w(SCLK)}$	SCLK pulse width		-	40	-	ns
$t_{w(SCLKH)}$	SCLK HIGH pulse width		-	16	-	ns
$t_{w(SCLKL)}$	SCLK LOW pulse width		-	16	-	ns
t_{su}	set-up time	data to SCLK HIGH	-	5	-	ns
		\overline{CS} to SCLK HIGH	-	5	-	ns
t_h	hold time	data to SCLK HIGH	-	2	-	ns
		\overline{CS} to SCLK HIGH	-	2	-	ns
$f_{clk(max)}$	maximum clock frequency		-	25	-	MHz

[1] Typical values measured at $V_{DDA} = 3\text{ V}$, $V_{DDO} = 1.8\text{ V}$, $T_{amb} = 25\text{ }^\circ\text{C}$; minimum and maximum values are across the full temperature range $T_{amb} = -40\text{ }^\circ\text{C}$ to $+85\text{ }^\circ\text{C}$ at $V_{DDA} = 3\text{ V}$, $V_{DDO} = 1.8\text{ V}$.

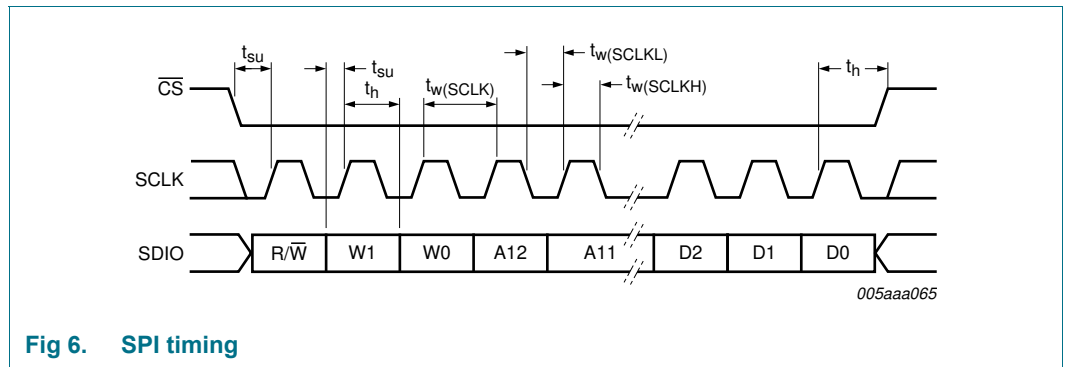


Fig 6. SPI timing

10.4 Typical characteristics

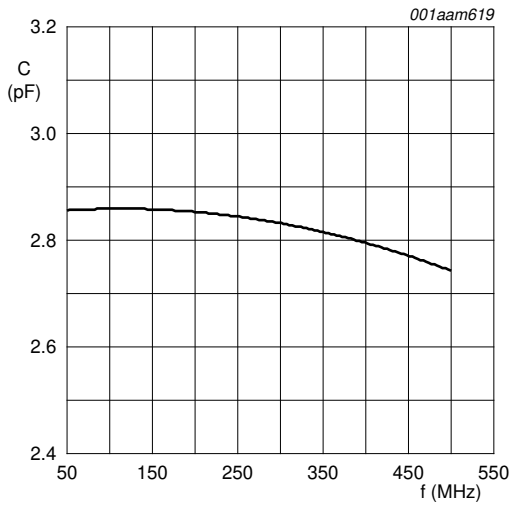


Fig 7. Capacitance as a function of frequency

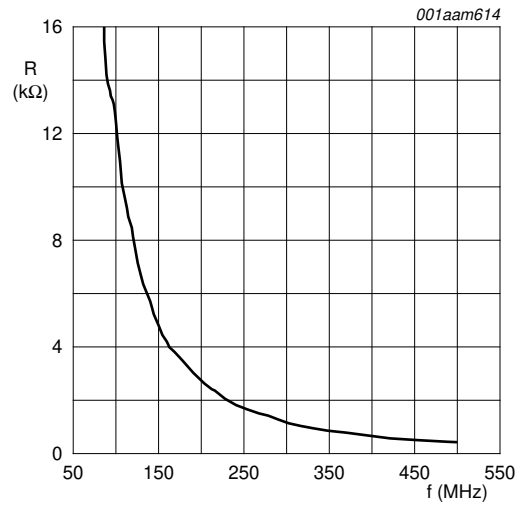
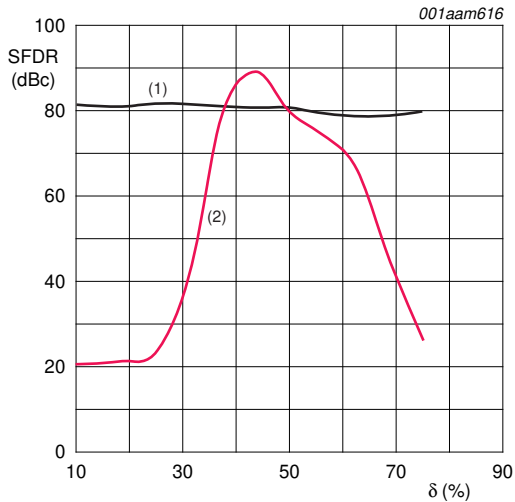
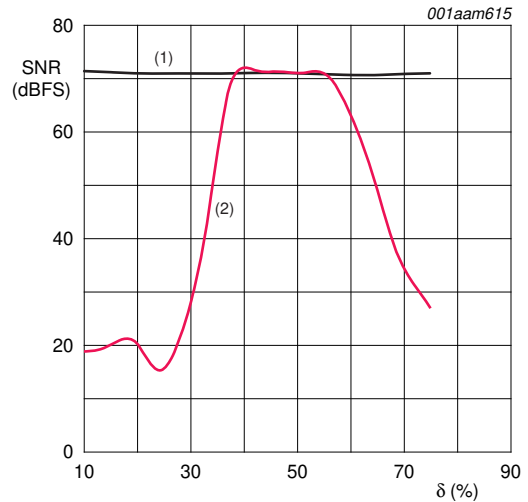


Fig 8. Resistance as a function of frequency



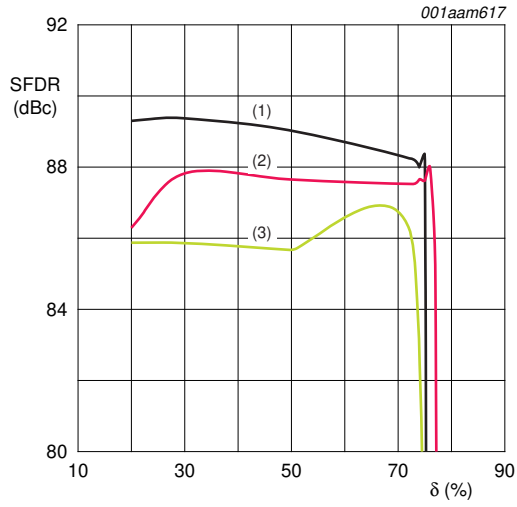
$T = 25\text{ }^{\circ}\text{C}; V_{DD} = 3\text{ V}; f_i = 170\text{ MHz}; f_s = 125\text{ Msps}$
 (1) DCS on
 (2) DCS off

Fig 9. SFDR as a function of duty cycle (δ)



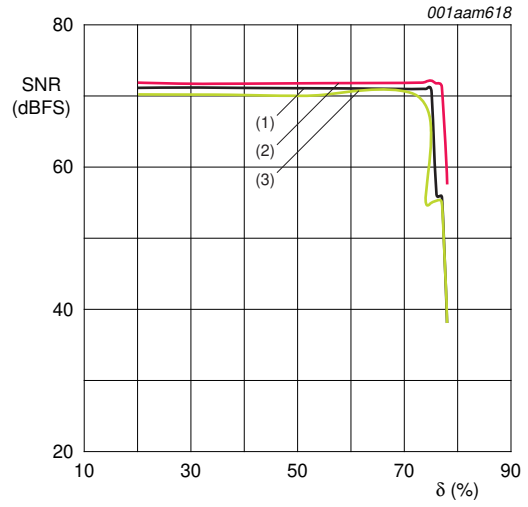
$T = 25\text{ }^{\circ}\text{C}; V_{DD} = 3\text{ V}; f_i = 170\text{ MHz}; f_s = 125\text{ Msps}$
 (1) DCS on
 (2) DCS off

Fig 10. SNR as a function of duty cycle (δ)



- (1) $T_{amb} = -40^\circ\text{C}$ /typical supply voltages
- (2) $T_{amb} = +25^\circ\text{C}$ /typical supply voltages
- (3) $T_{amb} = +90^\circ\text{C}$ /typical supply voltages

Fig 11. SFDR as a function of duty cycle (δ)



- (1) $T_{amb} = -40^\circ\text{C}$ /typical supply voltages
- (2) $T_{amb} = +25^\circ\text{C}$ /typical supply voltages
- (3) $T_{amb} = +90^\circ\text{C}$ /typical supply voltages

Fig 12. SNR as a function of duty cycle (δ)

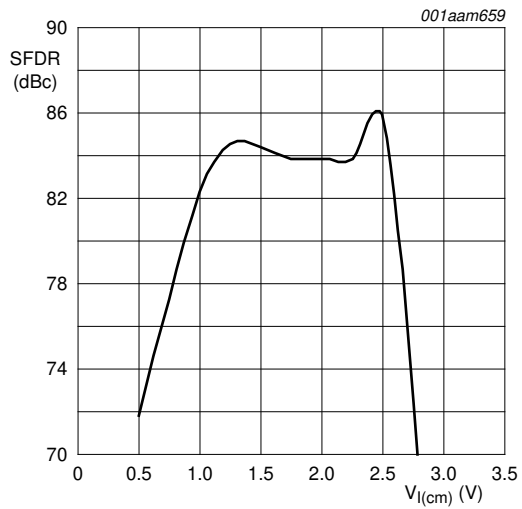


Fig 13. SFDR as a function of common-mode input voltage ($V_{I(cm)}$)

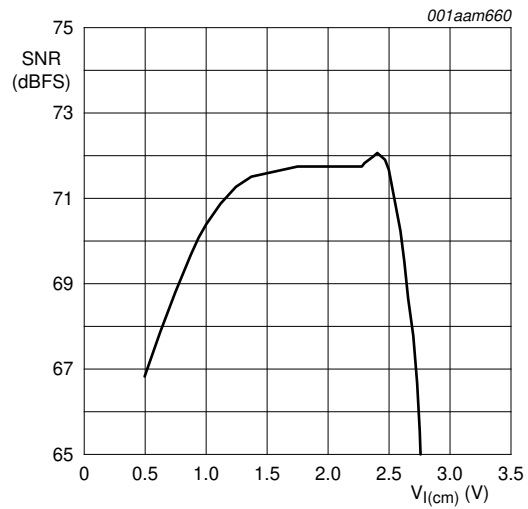


Fig 14. SNR as a function of common-mode input voltage ($V_{I(cm)}$)

11. Application information

11.1 Device control

The ADC1112D125 can be controlled via the Serial Peripheral Interface (SPI control mode) or directly via the I/O pins (Pin control mode).

11.1.1 SPI and Pin control modes

The device enters Pin control mode at power-up and remains in this mode as long as pin \overline{CS} is held HIGH. In Pin control mode, the SPI pins SDIO, \overline{CS} and SCLK are used as static control pins.

SPI control mode is enabled by forcing pin \overline{CS} LOW. Once SPI control mode has been enabled, the device remains in this mode. The transition from Pin control mode to SPI control mode is illustrated in Figure 15.

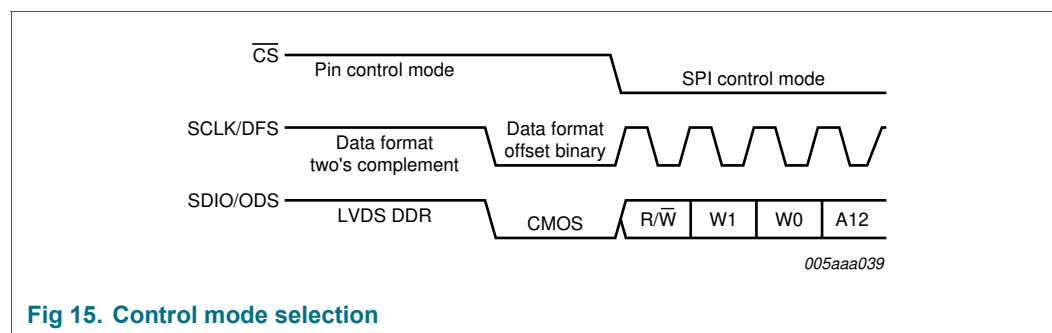


Fig 15. Control mode selection

When the device enters SPI control mode, the output data standard and data format are determined by the level on pin SDIO as soon as a transition is triggered by a falling edge on \overline{CS} .

11.1.2 Operating mode selection

The active ADC1112D125 operating mode (Power-up, Power-down or Sleep) can be selected via the SPI interface (see Table 21) or by using pin CTRL in Pin control mode.

Table 10. Operating mode selection via pin CTRL

Pin CTRL	Operating mode	Output high-Z
0	Power-down	yes
$0.3V_{DDA}$	Sleep	yes
$0.6V_{DDA}$	Power-up	yes
V_{DDA}	Power-up	no

11.1.3 Selecting the output data standard

The output data standard (CMOS or LVDS DDR) can be selected via the SPI interface (see Table 24) or by using pin ODS in Pin control mode. LVDS DDR is selected when ODS is HIGH, otherwise CMOS is selected.

11.1.4 Selecting the output data format

The output data format can be selected via the SPI interface (offset binary, two's complement or gray code; see Table 24) or by using pin DFS in Pin control mode (offset binary or two's complement). Offset binary is selected when DFS is LOW. When DFS is HIGH, two's complement is selected.

11.2 Analog inputs

11.2.1 Input stage

The analog input of the ADC1112D125 supports a differential or a single-ended input drive. Optimal performance is achieved using differential inputs with the common-mode input voltage ($V_{I(cm)}$) on pins INAP, INAM, INBP and INBM set to $0.5V_{DDA}$.

The full-scale analog input voltage range is configurable between 1 V (p-p) and 2 V (p-p) via a programmable internal reference (see Section 11.3 and Table 23).

The equivalent circuit of the sample-and-hold input stage, including ElectroStatic Discharge (ESD) protection and circuit and package parasitics, is shown in Figure 16.

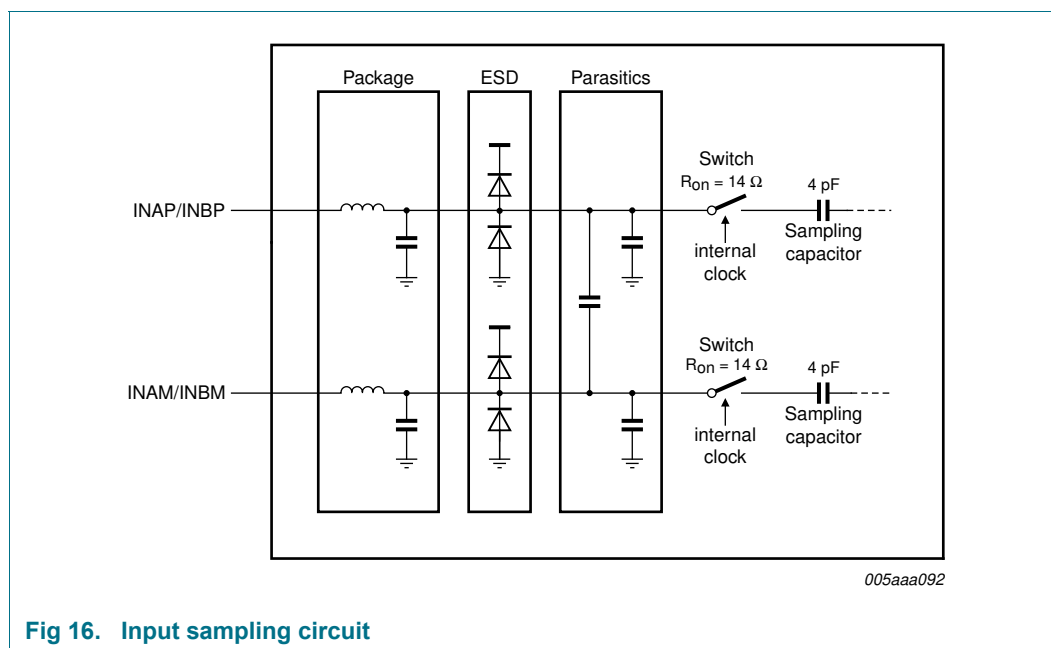


Fig 16. Input sampling circuit

The sample phase occurs when the internal clock (derived from the clock signal on pin CLKP/CLKM) is HIGH. The voltage is then held on the sampling capacitors. When the clock signal goes LOW, the stage enters the hold phase and the voltage information is transmitted to the ADC core.

11.2.2 Anti-kickback circuitry

Anti-kickback circuitry (RC filter in Figure 17 is needed to counteract the effects of charge injection generated by the sampling capacitance.

The RC-filter is also used to filter noise from the signal before it reaches the sampling stage. The value of the capacitor should be chosen to maximize noise attenuation without degrading the settling time excessively.

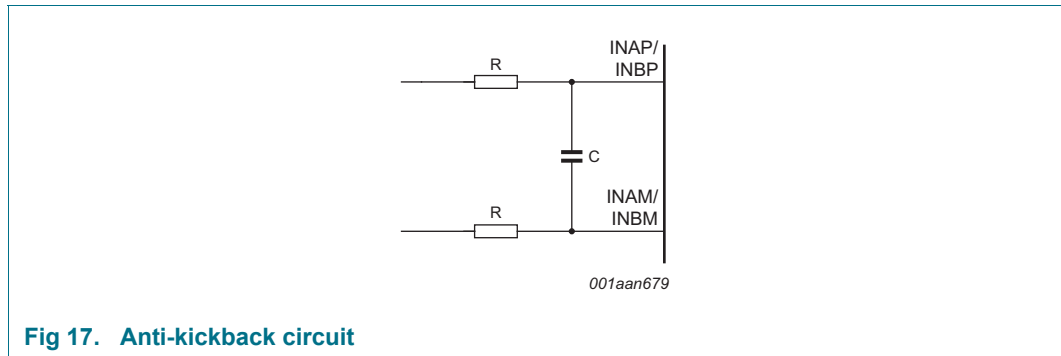


Fig 17. Anti-kickback circuit

The component values are determined by the input frequency and should be selected so as not to affect the input bandwidth.

Table 11. RC coupling versus input frequency, typical values

Input frequency (MHz)	R (Ω)	C (pF)
3	25	12
70	12	8
170	12	8

11.2.3 Transformer

The configuration of the transformer circuit is determined by the input frequency. The configuration shown in Figure 18 would be suitable for a baseband application.

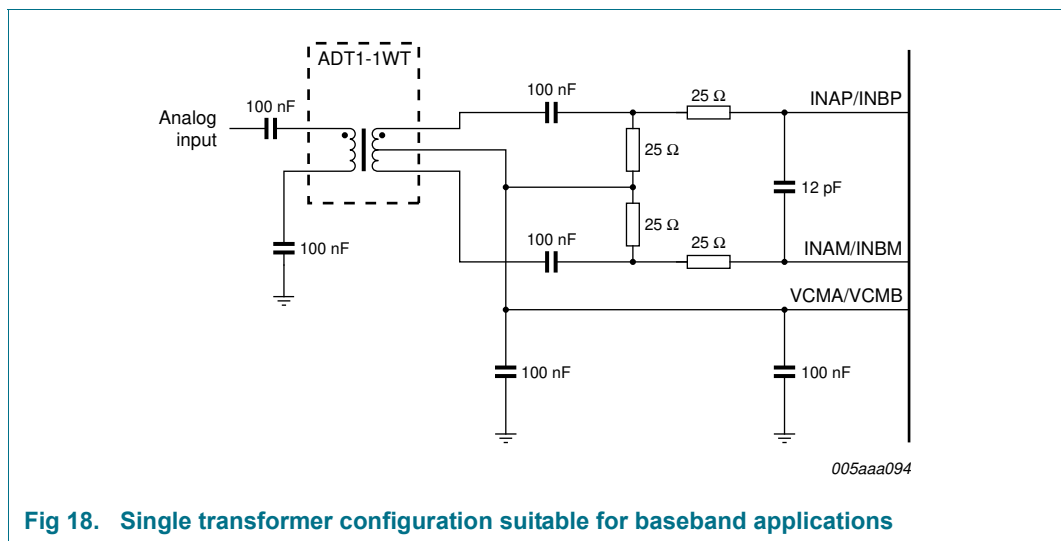
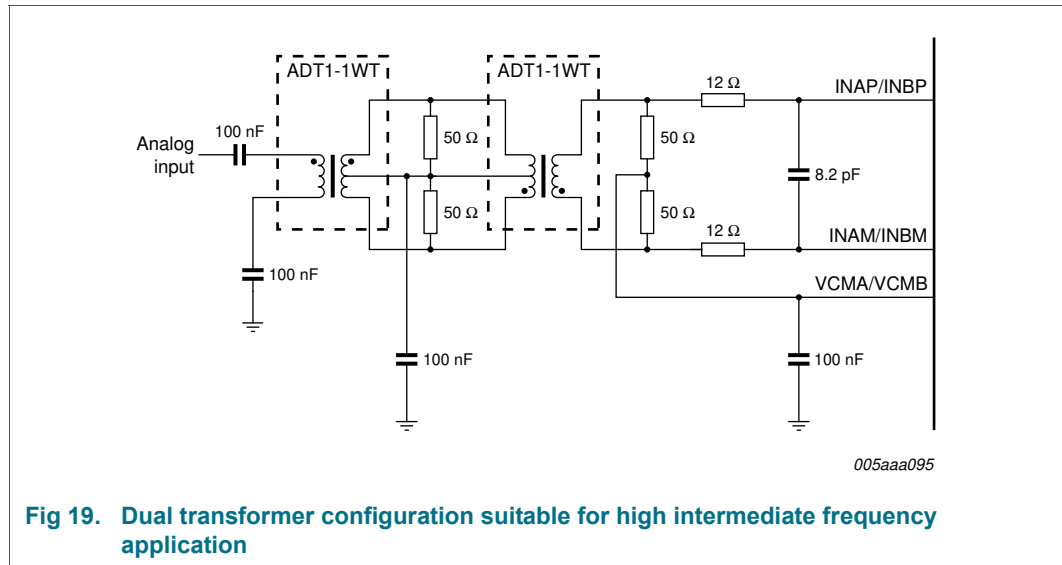


Fig 18. Single transformer configuration suitable for baseband applications

The configuration shown in Figure 19 is recommended for high frequency applications. In both cases, the choice of transformer is a compromise between cost and performance.



11.3 System reference and power management

11.3.1 Internal/external references

The ADC1112D125 has a stable and accurate built-in internal reference voltage to adjust the ADC full-scale. This reference voltage can be set internally via SPI or with pins VREF and SENSE (programmable in 1 dB steps between 0 dB and -6 dB via control bits INTREF[2:0] when bit INTREF_EN = logic 1; see Table 23). See Figure 21 to Figure 24. The equivalent reference circuit is shown in Figure 20. An external reference is also possible by providing a voltage on pin VREF as described in Figure 23.

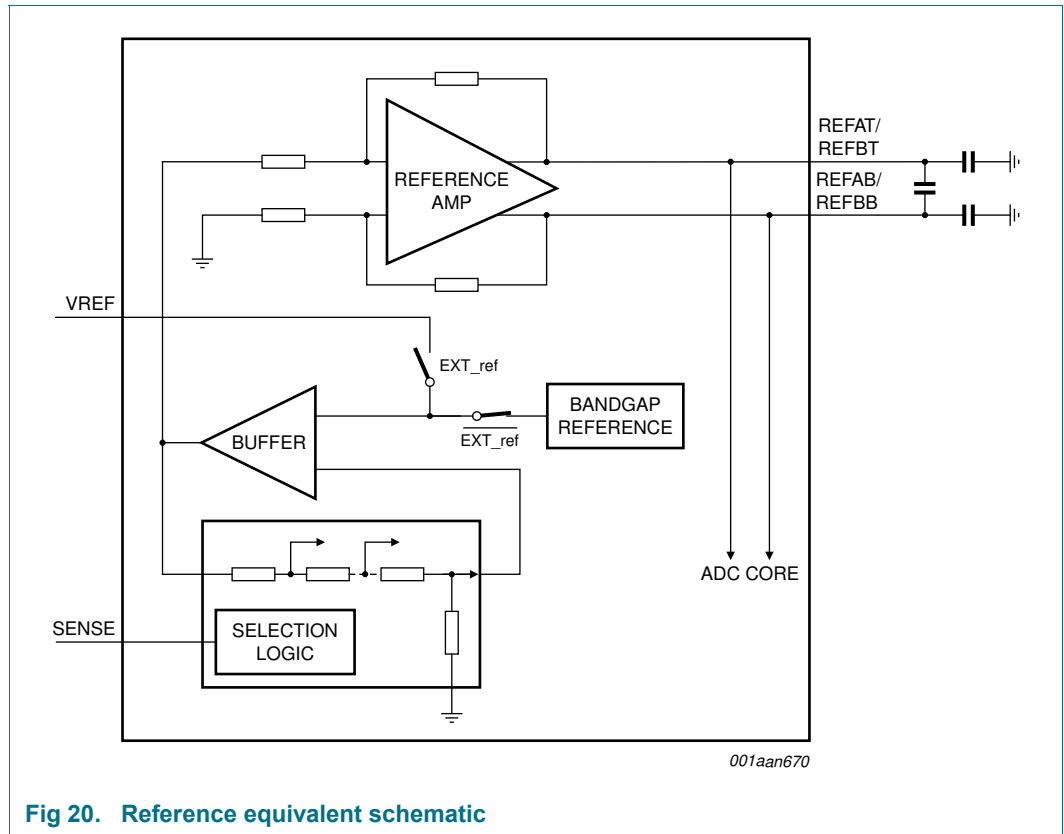


Fig 20. Reference equivalent schematic

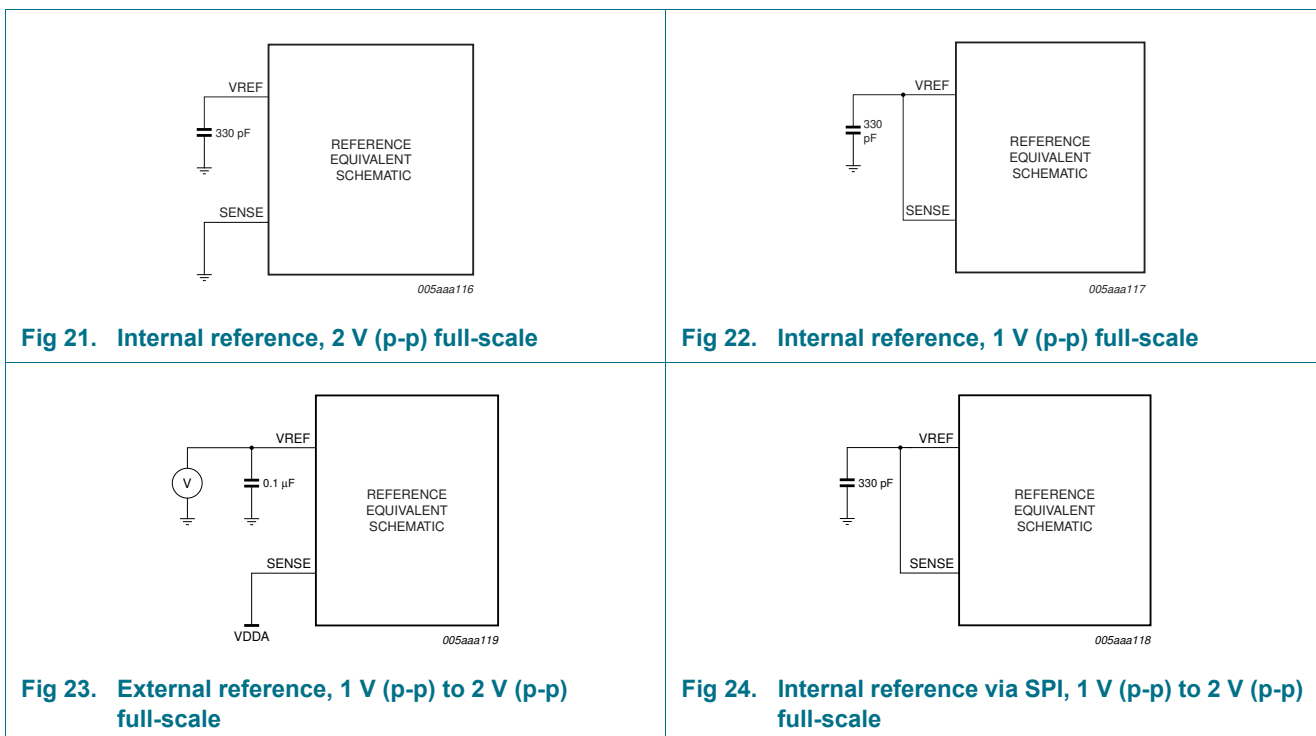
If bit INTREF_EN is set to logic 0, the reference voltage is determined either internally or externally as detailed in Table 12.

Table 12. Reference selection

Selection	SPI bit INTREF_EN	SENSE pin	VREF pin	Full-scale (V (p-p))
Internal (Figure 21)	0	AGND	330 pF capacitor to AGND	2 V
Internal (Figure 22)	0	pin VREF connected to pin SENSE and via a 330 pF capacitor to AGND		1 V
External (Figure 23)	0	V _{DDA}	external voltage between 0.5 V and 1 V ^[1]	1 V to 2 V
Internal via SPI (Figure 24)	1	pin VREF connected to pin SENSE and via 330 pF capacitor to AGND		1 V to 2 V

[1] The voltage on pin VREF is doubled internally to generate the internal reference voltage.

Figure 21 to Figure 24 illustrate how to connect the SENSE and VREF pins to select the required reference voltage source.



11.3.2 Programmable full-scale

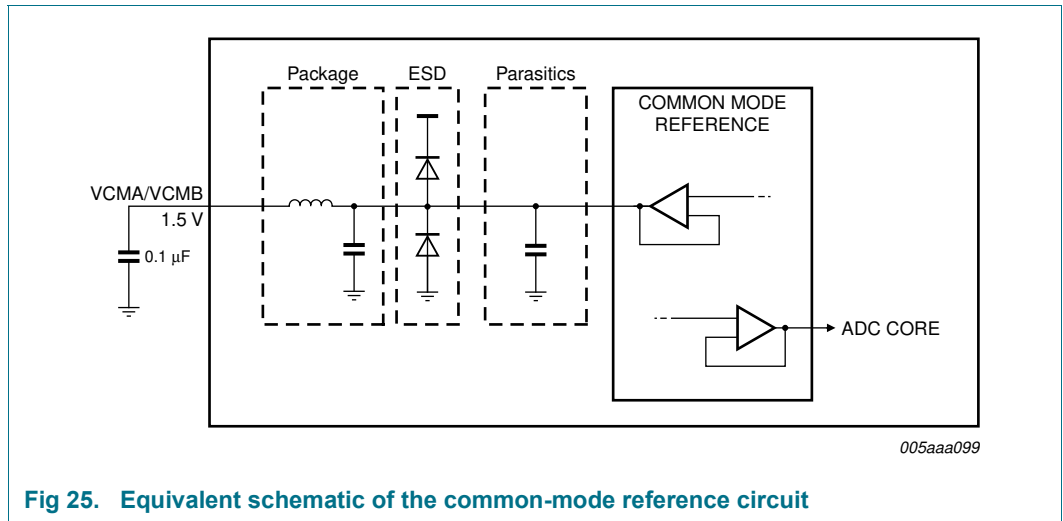
The full-scale is programmable between 1 V (p-p) to 2 V (p-p) (see Table 13).

Table 13. Programmable full-scale

INTREF	Level (dB)	Full-scale (V (p-p))
000	0	2
001	-1	1.78
010	-2	1.59
011	-3	1.42
100	-4	1.26
101	-5	1.12
110	-6	1
111	reserved	x

11.3.3 Common-mode output voltage ($V_{O(cm)}$)

A 0.1 μ F filter capacitor should be connected between pin VCMA/VCMB and ground to ensure a low-noise common-mode output voltage. When AC-coupled, pin VCMA/VCMB can then be used to set the common-mode reference for the analog inputs, for instance via a transformer middle point.



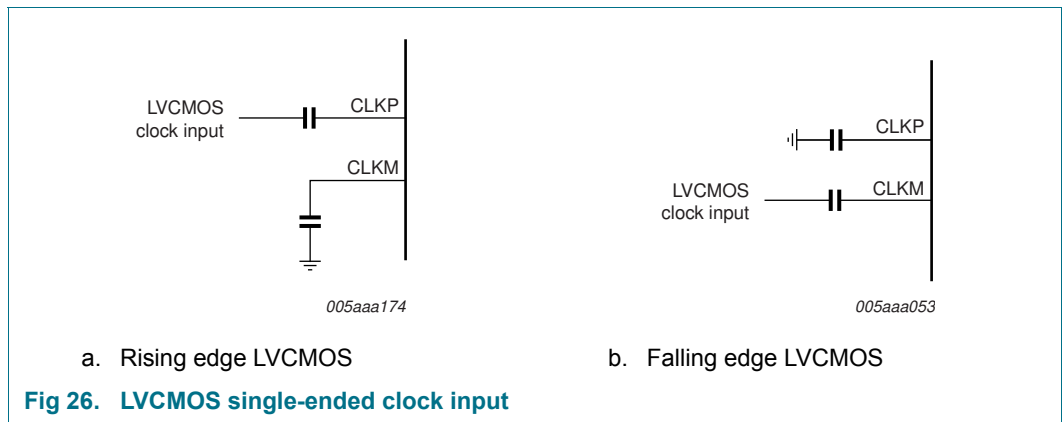
11.3.4 Biasing

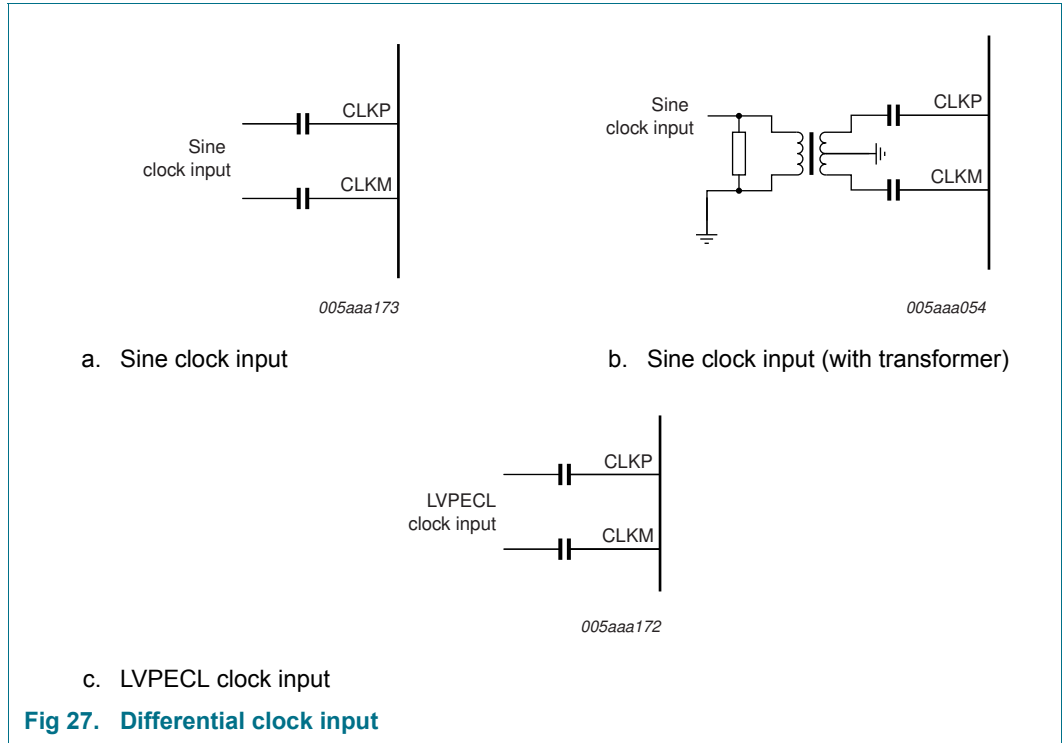
The common-mode input voltage ($V_{I(cm)}$) on pins INAP/INBP and INAM/INBM should be set externally to 0.5VDDA for optimal performance and should always be between 0.9 V and 2 V (see Table 6).

11.4 Clock input

11.4.1 Drive modes

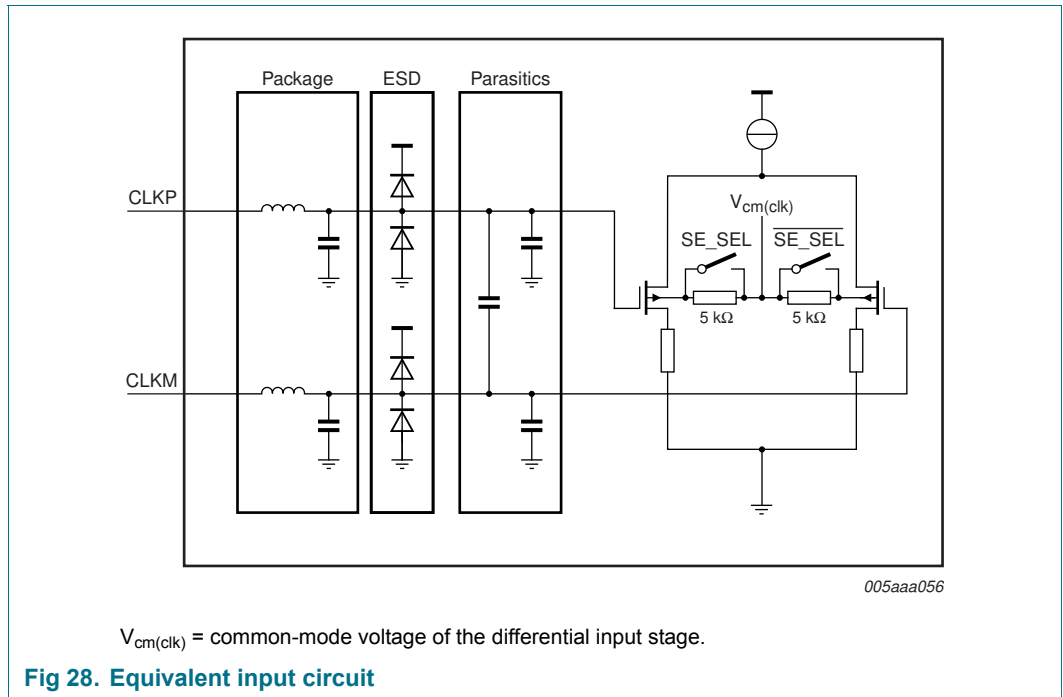
The ADC1112D125 can be driven differentially (LVPECL). It can also be driven by a single-ended LVCMOS signal connected to pin CLKP (pin CLKM should be connected to ground via a capacitor) or pin CLKM (pin CLKP should be connected to ground via a capacitor).





11.4.2 Equivalent input circuit

The equivalent circuit of the input clock buffer is shown in Figure 28. The common-mode voltage of the differential input stage is set via internal 5 kΩ resistors.



Single-ended or differential clock inputs can be selected via the SPI interface (see Table 22). If single-ended is enabled, the input pin (CLKM or CLKP) is selected via control bit SE_SEL.

If single-ended is implemented without setting bit SE_SEL to the appropriate value, the unused pin should be connected to ground via a capacitor.

11.4.3 Duty cycle stabilizer

The duty cycle stabilizer can improve the overall performance of the ADC by compensating the duty cycle of the input clock signal. When the duty cycle stabilizer is active (bit DCS_EN = logic 1; see Table 22), the circuit can handle signals with duty cycles of between 30 % and 70 % (typical). When the duty cycle stabilizer is disabled (DCS_EN = logic 0), the input clock signal should have a duty cycle of between 45 % and 55 %.

11.4.4 Clock input divider

The ADC1112D125 contains an input clock divider that divides the incoming clock by a factor of 2 (when bit CLKDIV = logic 1; see Table 22). This feature allows the user to deliver a higher clock frequency with better jitter performance, leading to a better SNR result once acquisition has been performed.

11.5 Digital outputs

11.5.1 Digital output buffers: CMOS mode

The digital output buffers can be configured as CMOS by setting bit LVDS_CMOS to logic 0 (see Table 24).

Each digital output has a dedicated output buffer. The equivalent circuit of the CMOS digital output buffer is shown in Figure 29. The buffer is powered by a separate AGND/V_{DDO} to ensure 1.8 V to 3.3 V compatibility and is isolated from the ADC core. Each buffer can be loaded by a maximum of 10 pF.

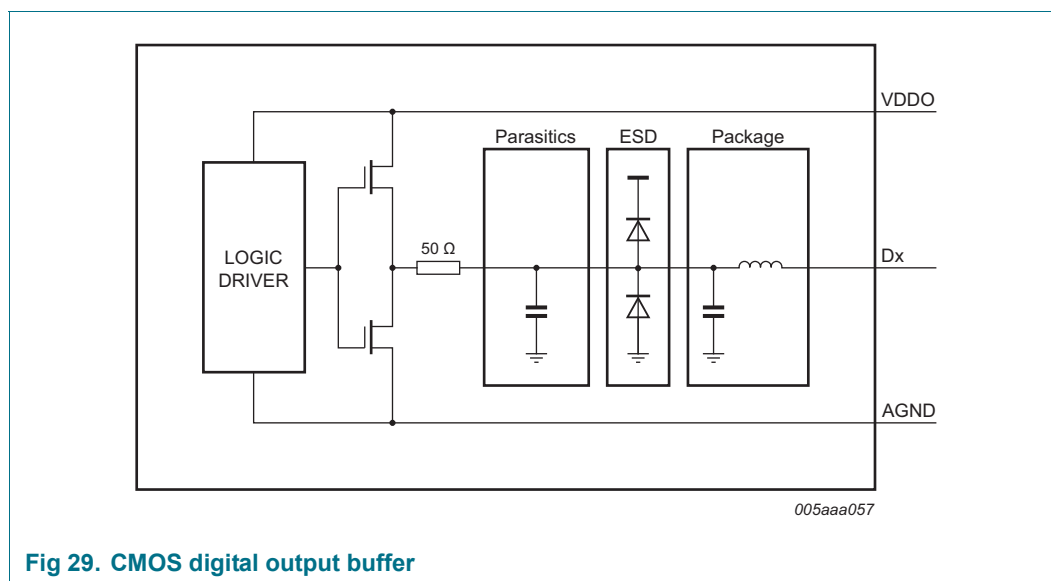


Fig 29. CMOS digital output buffer

The output resistance is 50 Ω and is the combination of an internal resistor and the equivalent output resistance of the buffer. There is no need for an external damping resistor. The drive strength of both DATA and DAV buffers can be programmed via the SPI in order to adjust the rise and fall times of the output digital signals (see Table 31).

11.5.2 Digital output buffers: LVDS DDR mode

The digital output buffers can be configured as LVDS DDR by setting bit LVDS_CMOS to logic 1 (see Table 24).

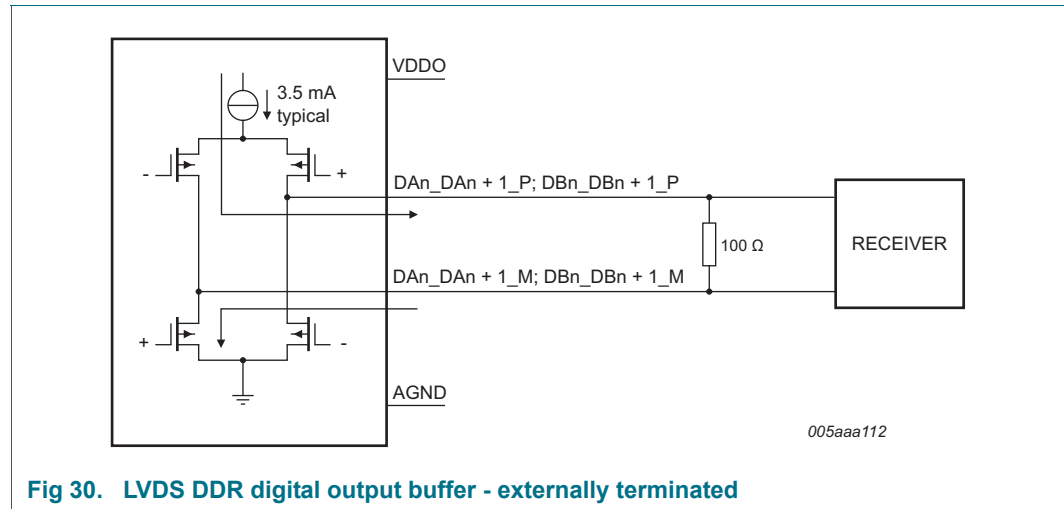


Fig 30. LVDS DDR digital output buffer - externally terminated

Each output should be terminated externally with a 100 Ω resistor (typical) at the receiver side (Figure 30) or internally via SPI control bits LVDS_INT_TER[2:0] (see Figure 31 and Table 33).

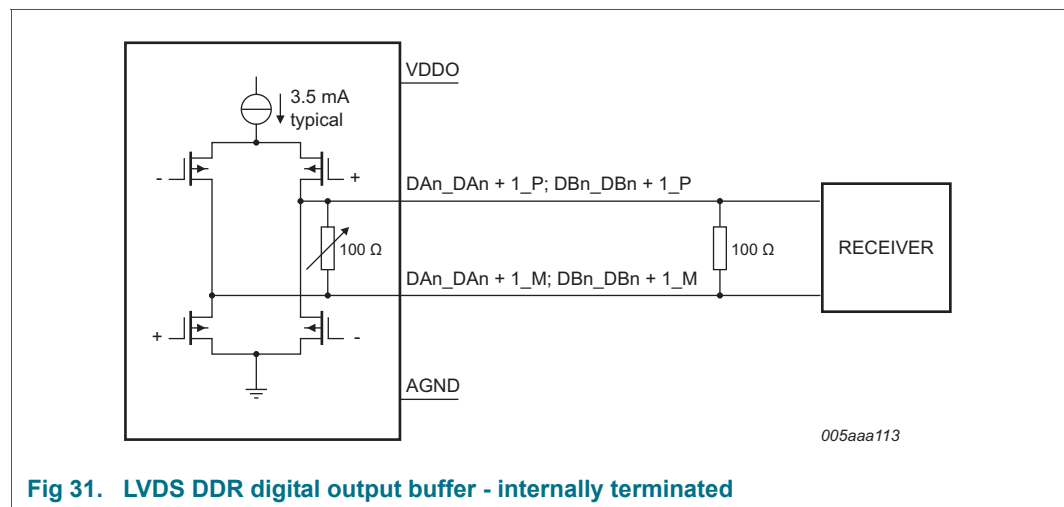


Fig 31. LVDS DDR digital output buffer - internally terminated

The default LVDS DDR output buffer current is set to 3.5 mA. It can be programmed via the SPI (bits DAVI[1:0] and DATAI[1:0]; see Table 32) in order to adjust the output logic voltage levels.